

CLAIMS

The invention claimed is:

1. A method of forming a phosphorus doped silicon dioxide comprising layer, comprising:

positioning a substrate within a deposition chamber; and

introducing first and second vapor phase reactants in alternate and temporally separated pulses to the substrate within the chamber in a plurality of deposition cycles under conditions effective to deposit a phosphorus doped silicon dioxide comprising layer on the substrate, one of the first and second vapor phase reactants being $\text{PO}(\text{OR})_3$ where R is hydrocarbyl, and an other of the first and second vapor phase reactants being $\text{Si}(\text{OR})_3\text{OH}$ where R is hydrocarbyl.

2. The method of claim 1 wherein the conditions comprise atomic layer deposition.

3. The method of claim 1 wherein the conditions are effective to form the silicon dioxide comprising layer to have no more than 0.5 atomic percent phosphorus.

4. The method of claim 1 wherein the conditions are effective to form the silicon dioxide comprising layer to have at least 1.0 atomic percent phosphorus.

5. The method of claim 1 being void of introducing any vapor phase reactant to the chamber other than said first and second vapor phase reactants in said forming of the phosphorus doped silicon dioxide comprising layer.

6. The method of claim 1 comprising introducing another vapor phase reactant different from the first and second vapor phase reactants intermediate at least some of said separated pulses of the first and second vapor phase reactants.

7. The method of claim 6 wherein the another vapor phase reactant is oxygen containing.

8. The method of claim 7 wherein the another vapor phase reactant comprises O₃.

9. The method of claim 6 wherein the another vapor phase reactant is boron containing, the phosphorus doped silicon dioxide comprising layer comprising boron.

10. The method of claim 1 wherein the R hydrocarbyl of the $\text{PO}(\text{OR})_3$ contains only from one to five carbon atoms.
11. The method of claim 1 wherein the R hydrocarbyl of the $\text{Si}(\text{OR})_3\text{OH}$ contains only from one to five carbon atoms.
12. The method of claim 1 wherein the $\text{PO}(\text{OR})_3$ comprises triethyl phosphate.
13. The method of claim 1 wherein the $\text{Si}(\text{OR})_3\text{OH}$ comprises tris(tert-butoxy)silanol.
14. The method of claim 1 wherein the $\text{PO}(\text{OR})_3$ comprises triethyl phosphate, and wherein the $\text{Si}(\text{OR})_3\text{OH}$ comprises tris(tert-butoxy)silanol.
15. The method of claim 1 wherein the conditions comprise a temperature from about 50°C to about 500°C.
16. The method of claim 15 wherein the conditions comprise a temperature from about 100°C to about 300°C.
17. The method of claim 1 wherein the conditions comprise a pressure from about 10^{-7} Torr to about 10 Torr.

18. The method of claim 1 wherein the conditions comprise plasma generation of at least one of the first and second reactants.

19. The method of claim 1 wherein the conditions are void of plasma generation of the first and second reactants.

20. The method of claim 1 comprising purging the chamber with an inert gas intermediate the separated pulses.

21. The method of claim 1 being void of aluminum on the substrate in said forming of the phosphorus doped silicon dioxide comprising layer.

22. The method of claim 1 being void of introducing any vapor phase aluminum containing reactant to the chamber in said forming of the phosphorus doped silicon dioxide comprising layer.

23. A method of forming a phosphorus doped silicon dioxide comprising layer, comprising:

positioning a substrate within a deposition chamber;

chemisorbing a first species to a surface of the substrate to form a first species monolayer onto the surface within the chamber from a first vapor phase reactant comprising $\text{PO}(\text{OR})_3$, where R is hydrocarbyl;

contacting the chemisorbed first species with a second vapor phase reactant comprising $\text{Si}(\text{OR})_3\text{OH}$, where R is hydrocarbyl, to form a monolayer comprising Si and O; and

successively repeating chemisorbing with the first species and contacting the chemisorbed first species with the second reactant under conditions effective to deposit a phosphorus doped silicon dioxide comprising layer on the substrate.

24. The method of claim 23 wherein the substrate surface to which the first species is at least first chemisorbed is provided to be an hydroxylated surface.

25. The method of claim 23 wherein the conditions are effective to form the silicon dioxide comprising layer to have no more than 0.5 atomic percent phosphorus.

26. The method of claim 23 wherein the conditions are effective to form the silicon dioxide comprising layer to have at least 1.0 atomic percent phosphorus.

27. The method of claim 24 being void of introducing any vapor phase reactant to the chamber other than said first and second vapor phase reactants at least after providing the hydroxylated surface in said forming of the phosphorus doped silicon dioxide comprising layer.

28. The method of claim 23 comprising introducing another vapor phase reactant different from the first and second vapor phase reactants intermediate at least some of said repeated chemisorbings and contactings.

29. The method of claim 28 wherein the another vapor phase reactant is oxygen containing.

30. The method of claim 29 wherein the another vapor phase reactant comprises O₃.

31. The method of claim 28 wherein the another vapor phase reactant is boron containing, the phosphorus doped silicon dioxide comprising layer comprising boron.

32. The method of claim 23 wherein the R hydrocarbyl of the $\text{PO}(\text{OR})_3$ contains only from one to five carbon atoms.

33. The method of claim 23 wherein the R hydrocarbyl of the $\text{Si}(\text{OR})_3\text{OH}$ contains only from one to five carbon atoms.

34. The method of claim 23 wherein the $\text{PO}(\text{OR})_3$ comprises triethyl phosphate.

35. The method of claim 23 wherein the $\text{Si}(\text{OR})_3\text{OH}$ comprises tris(tert-butoxy)silanol.

36. The method of claim 23 wherein the $\text{PO}(\text{OR})_3$ comprises triethyl phosphate, and wherein the $\text{Si}(\text{OR})_3\text{OH}$ comprises tris(tert-butoxy)silanol.

37. The method of claim 23 comprising purging the chamber with an inert gas intermediate said repeated chemisorbings and contactings.

38. The method of claim 23 being void of aluminum on the substrate in said forming of the phosphorus doped silicon dioxide comprising layer.

39. The method of claim 23 being void of introducing any vapor phase aluminum containing reactant to the chamber in said forming of the phosphorus doped silicon dioxide comprising layer.

40. The method of claim 23 comprising depositing the phosphorus doped silicon dioxide comprising layer within semiconductive material isolation trenches formed in the substrate.

41. A method of forming trench isolation in the fabrication of integrated circuitry, comprising:

forming a masking layer over a semiconductor substrate;

etching isolation trenches through the masking layer into semiconductive material of the semiconductor substrate; and

after etching the isolation trenches, introducing first and second vapor phase reactants in alternate and temporally separated pulses to the substrate within the chamber in a plurality of deposition cycles effective to deposit a phosphorus doped silicon dioxide comprising layer within the isolation trenches, one of the first and second vapor phase reactants being $\text{PO}(\text{OR})_3$ where R is hydrocarbyl, and an other of the first and second vapor phase reactants being $\text{Si}(\text{OR})_3\text{OH}$ where R is hydrocarbyl.

42. The method of claim 41 wherein the deposit is effective to fill the isolation trenches.

43. The method of claim 41 wherein the deposit does not fill the isolation trenches.

44. The method of claim 41 wherein the deposition cycles are effective to deposit the phosphorus doped silicon dioxide comprising layer on the masking layer.

45. The method of claim 41 wherein the deposition cycles are not effective to selectively deposit the phosphorus doped silicon dioxide comprising layer within the isolation trenches.

46. The method of claim 41 wherein the conditions are effective to form the silicon dioxide comprising layer to have no more than 0.5 atomic percent phosphorus.

47. The method of claim 41 wherein the conditions are effective to form the silicon dioxide comprising layer to have at least 1.0 atomic percent phosphorus.

48. The method of claim 41 being void of introducing any vapor phase reactant to the chamber other than said first and second vapor phase reactants in said forming of the phosphorus doped silicon dioxide comprising layer.

49. The method of claim 41 comprising introducing another vapor phase reactant different from the first and second vapor phase reactants intermediate at least some of said separated pulses of the first and second vapor phase reactants.

50. The method of claim 49 wherein the another vapor phase reactant is oxygen containing.

51. The method of claim 50 wherein the another vapor phase reactant comprises O₃.

52. The method of claim 49 wherein the another vapor phase reactant is boron containing, the phosphorus doped silicon dioxide comprising layer comprising boron.

53. The method of claim 41 wherein the PO(OR)₃ comprises triethyl phosphate.

54. The method of claim 41 wherein the Si(OR)₃OH comprises tris(tert-butoxy)silanol.

55. The method of claim 41 wherein the PO(OR)₃ comprises triethyl phosphate, and wherein the Si(OR)₃OH comprises tris(tert-butoxy)silanol.

56. The method of claim 41 comprising purging the chamber with an inert gas intermediate the separated pulses.

57. The method of claim 41 being void of aluminum on the substrate in said forming of the phosphorus doped silicon dioxide comprising layer.

58. The method of claim 41 being void of introducing any vapor phase aluminum containing reactant to the chamber in said forming of the phosphorus doped silicon dioxide comprising layer.